

Oct. 23, 1945.

L. E. HAYSLETT ET AL
REMOTE CONTROL APPARATUS

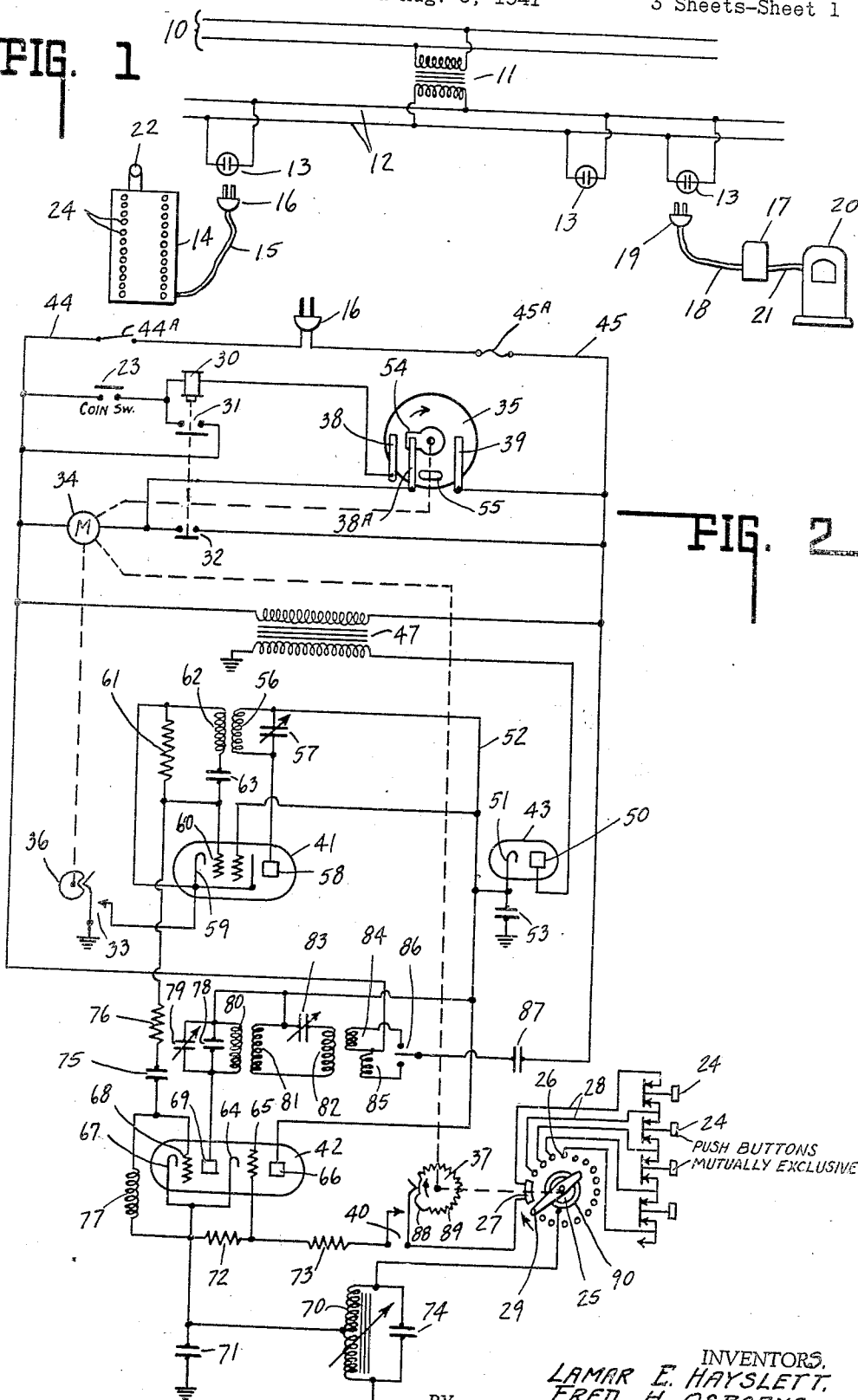
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REMOTE CONTROL APPARATUS

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3 Sheets-Sheet 1

FIG. 1



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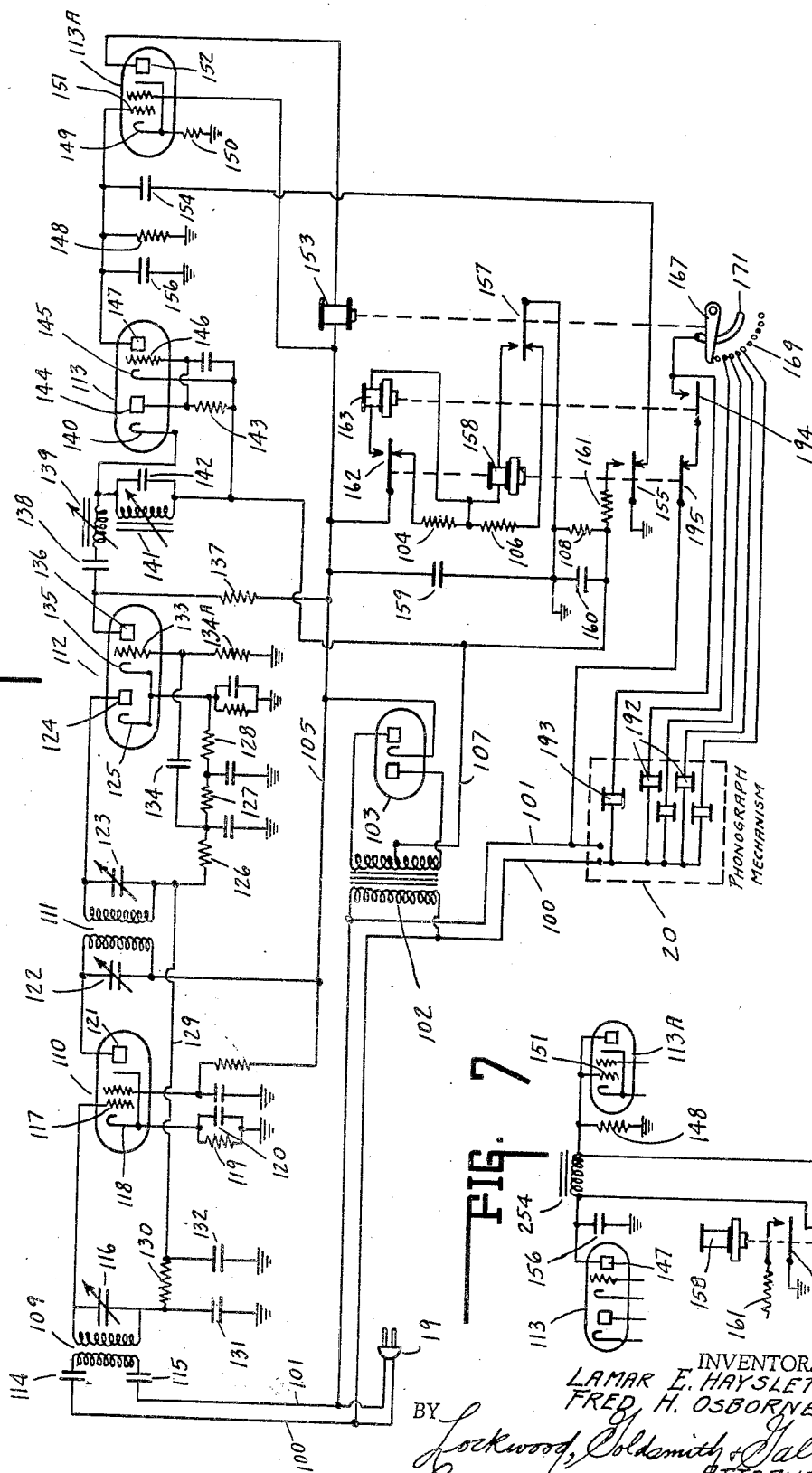
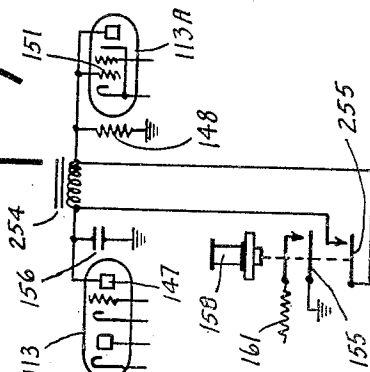


FIG. 7



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FIG. 4

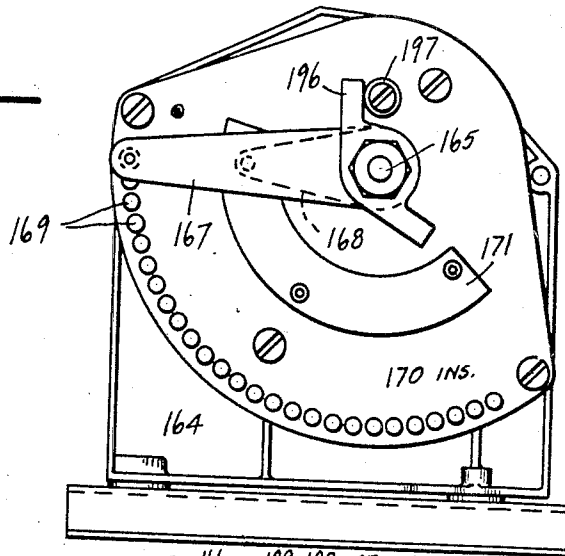


FIG. 5

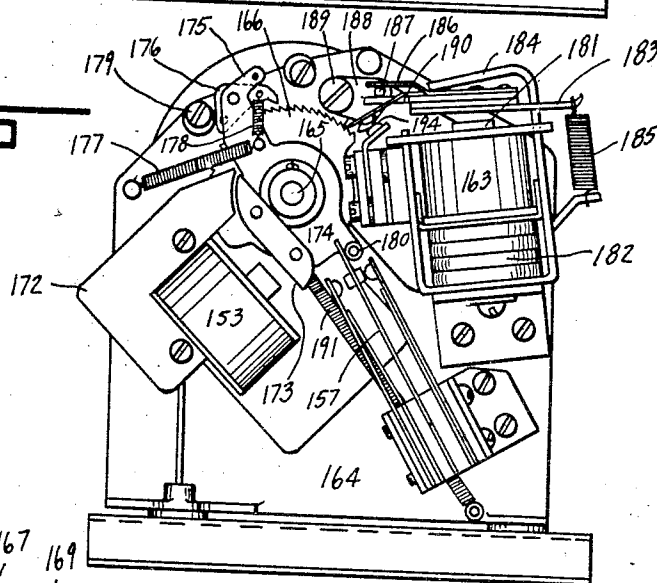
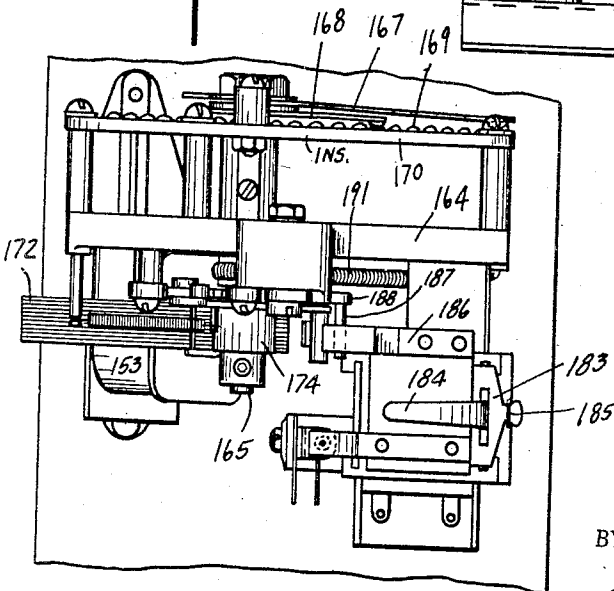


FIG. 6



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REMOTE CONTROL APPARATUS

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Application August 5, 1941, Serial No. 405,522

3 Claims. (Cl. 177-353)

This invention relates to a remote control apparatus which is particularly adapted to the selective control of automatic record changing phonographs but which is equally useful for the selective control of other mechanical or electrical apparatus.

The invention in its preferred form includes a transmitter adapted to generate electrical signals and a receiver adapted to receive said signals and to perform selective operations in response thereto. Preferably the signals are transmitted over power lines supplying power for operating the transmitter, the receiver and the controlled machine and said signals are in the form of a high frequency carrier wave modified by low frequency power impulses. However, many features of the invention are applicable to other types of signal transmission such as independent metallic circuits or radio communication between the transmitter and the receiver.

One object of the invention is to improve the speed and accuracy with which operating signals may be transmitted, received and acted upon by the receiver.

Another object of the invention is to improve the ability of the receiver to reject spurious signals received from outside sources.

Certain features of the apparatus disclosed in the present application are shown and claimed in co-pending application of Charles J. Hull and Fred H. Osborne, Serial No. 355,204, filed September 3, 1940, Patent No. 2,327,429 issued August 24, 1943, and co-pending application of Francis M. Schmidt and Gerald G. Smith, Serial No. 397,554, filed June 11, 1941, Patent No. 2,348,312 issued May 9, 1944.

Another object of the invention is generally to improve signal transmitting and receiving apparatus of the type disclosed in said co-pending applications.

Other objects and features of the invention will be understood from the accompanying drawings and the following description and claims:

Fig. 1 is a diagram showing in conventional form the relation of the remote station, the receiver and a controlled machine in a form of the invention in which signals are transmitted over power lines. Fig. 2 is a diagram of electrical connection and apparatus illustrating a preferred form of remote control station. Fig. 3 is a similar diagram illustrating a preferred form of receiving apparatus. Fig. 4 is an elevational view of certain mechanical parts of the receiving apparatus of Fig. 3. Fig. 5 is a similar view of the opposite side of said apparatus. Fig. 6 is a plan view of the

same. Fig. 7 is a diagram illustrating an alternative arrangement of a portion of the electrical apparatus of Fig. 3.

The invention in the preferred form illustrated in the drawings is designed for use in a home or commercial establishment which is provided with the usual electrical wiring having suitable outlet sockets to which the controlled machine and the remote control apparatus may be connected by the usual socket plugs. For use in a commercial application such as a restaurant, the control will ordinarily be dependent upon the insertion of a coin. Obviously for home use the coin control may be omitted. In Fig. 1 there is shown a pair of conductors 10 which may be considered as the distributory conductors of a commercial power company leading to the premises on which the invention is to be used. Connected to the conductors 10 there is shown the usual local transformer 11 having a secondary winding connected to power mains 12 supplying the individual customer of the power company. Suitable cutout switches and overload protection, not shown, may be assumed to be connected between the transformer 11 and the mains 12. Appliance outlet sockets 13 are connected to the mains 12 in the usual manner and may be placed at any desirable position on the premises. Adjacent any one of the outlets 13 there may be installed a signal transmitter 14 having a cord 15 and socket plug 16 which may be connected to the socket 13. A signal receiver 17 having a cord 18 and plug 19 may be similarly connected to another of the sockets 13. The machine to be controlled is shown in Fig. 1 in the form of an automatic record changing phonograph 20 connected to the signal receiver by a cord 21. If desired, the receiver 17 may be placed within the cabinet of the phonograph 20.

Signal transmitter

For coin operation, the signal transmitter 14 may be provided with a coin slot 22 of any well known form adapted to receive a coin of a given denomination. Within the receiver there is provided a switch 23 which may be momentarily closed upon the receipt of a coin in the coin slot 22 or which may be manually operated when suitable mechanism is unlocked by a coin in a well known manner. Many different forms of coin receiver, coin operated switches or coin controlled switches which may be used, are known in the art and it is therefore unnecessary to describe the same in detail.

There are also provided a group of manually operated normally closed push button switches 24,

the buttons of which extend through the face of the transmitter 14 and are accessible to an operator. Each of said switches may correspond to a desired operation of the controlled machine and as many such switches as desired may be used. In Fig. 2 only four are shown. If a greater number is necessary, they are connected in a similar manner. The push buttons 24 are mechanically connected in a well known manner so as to be mutually exclusive—that is, when any one of said buttons is pressed to open its switch, the button is latched in position and any button or buttons previously pressed are released to normal position. The mechanism by which this mechanical connection is accomplished is well known in the art and need not be described in detail.

There is also provided a motor driven multi-point switch 25 having a series of contact points 26 and a contact segment 27 connected by conductors 28 to the push button switches 24. Said switch has a contact finger 29 which is movable from an initial position shown in the drawings to engage successively the segment 27 and the contact points 26. Other electrical apparatus within the transmitter 14 includes an electromagnetic relay 30 adapted when energized to close a pair of normally open switches 31 and 32. A motor 34 is adapted to operate the multi-point switch 25 and to rotate a contact disc 35, a cam 36 and a cam 37. The mechanical connections of the motor to the switch 25, disc 35 and the cams 36 and 37 are indicated schematically in Fig. 2 by broken lines and it is to be understood that these connections are such that each of the driven parts makes one revolution in a definite period of time. The cam 36 operates a switch 33. The cam 37 operates a switch 40. The contact disc 35 is engaged by contact fingers 38, 38A and 39 between which electrical contact is made through said disc at certain points in the cycle of operation. The contact disc 35, the cams 36 and 37 and the switch 25 are shown in Fig. 2 in an initial idle position. Each cycle of motor operation starts with the parts in this idle position and continues until all of said parts are simultaneously returned to said position.

There are also provided electron discharge tubes 41, 42 and 43. Tube 41 is shown as a standard pentode tube and is used as a generator of radio frequency energy. Tube 42 is a twin triode tube. One of the triode elements is used as a radio frequency amplifier and modulator and the other as an audio frequency oscillator. Obviously, two standard triode tubes could be used in place of the single tube 42. Tube 43 is shown as a diode tube connected as a half wave rectifier to supply the necessary D. C. plate voltages for tubes 41 and 42. In practice it is advantageous to combine the elements of tubes 41 and 43 in a single tube but separate tubes are illustrated in the drawings for the sake of simplicity.

Power for operating the transmitter is supplied from the plug 16 to a pair of line conductors 44 and 45 in one of which there may be placed a cut-out switch 44A and in the other an overload fuse 45A. A transformer 47 has its primary winding connected to the line conductors 44 and 45 and its secondary winding arranged to supply current for the rectifier tube 43. One terminal of the secondary winding of transformer 47 is grounded and the opposite terminal is connected to the anode 50 of the rectifier tube 43. The cathode 51 of said tube is connected to a distributory conductor 52 which is maintained thereby at a suitable potential above ground and supplies the

necessary D. C. potential for the plate circuits of tubes 41 and 42. A condenser 53 connected between the cathode and ground serves to smooth out the D. C. voltage.

The cathodes of the several tubes may be heated by heating elements connected to suitable taps on the primary or secondary windings of the transformer 47 in a conventional manner.

The remaining electrical apparatus illustrated in Fig. 1 may best be described in connection with the circuits in which they are included.

In the operation of the transmitter, one of the push buttons 24 is first pressed to open its corresponding switch. Each of said push buttons corresponds to an operation of the controlled machine and in the case of a selective record changing phonograph, each of said buttons corresponds to one of the records carried in the magazine of said phonograph. When one of the buttons 24 has been pressed, a coin is deposited and switch 23 is momentarily closed to complete a circuit for the winding of relay 30 from the line conductor 44 through switch 23, relay 30, finger 38, disc 35 and finger 39 to line conductor 45. The consequent actuation of relay 30 closes switch 31 which is in parallel with switch 23 and thus retains the relay in energized condition after switch 23 has been opened.

The operation of relay 30 also closes switch 32 and completes a circuit through said switch to start the motor 34. The first movement of the motor moves the contact disc 35 to bring finger 38A into engagement therewith. The resulting electrical connection from finger 38A through disc 35 and finger 39 to the line conductor 45 short circuits the switch 32. The motor thus continues to operate until disc 35 has made a complete revolution and a recess 54 in said disc reaches the finger 38A and breaks the last mentioned electrical connection. This occurs when the parts have returned to their idle position and a complete cycle of motor operation is thus obtained even though switch 32 is opened during the cycle.

At a convenient point in the cycle of motor operation an opening 55 in the contact disc 35 engages the finger 38 and breaks the circuit through the relay 30. Said relay thus returns to normal position with the switches 31 and 32 open.

By means of the apparatus just described, an extremely brief momentary operation of the switch 23 results in a complete cycle of motor operation. The retaining or "stick" circuit for the relay through switch 31 and the retaining circuit for the motor through fingers 38A and 39 insure positive operation of the cycle even though the closure of switch 23 is too brief in itself to give a positive initiation to the motor operation.

At the beginning of a cycle, the operation of the motor moves cam 36 to close switch 33 and said switch remains closed throughout the cycle of operation. The closing of switch 33 starts the operation of the radio frequency oscillator tube 41. Said tube is provided with a conventional anode-cathode circuit leading from the D. C. distributory conductor 52, through inductance 56 and tuning condenser 57 in parallel to the anode 58 and thence through the cathode 59 and switch 33 to ground. The grid-cathode circuit leads from cathode 59 to control grid 60 through resistor 61 and the parallel path formed by inductance 62 and condenser 63. Inductance 56 and 62 are coupled to give the necessary feed-

back for oscillation and the frequency of oscillation is controlled by the tuning condenser 57. Preferably oscillations of the order of 250 kc. are used. Since switch 33 is included in the anode-cathode circuit, radio frequency energy is generated in the circuits of said tube only when switch 33 is closed.

The radio frequency energy generated in the tube 41 is amplified and power modulated by the tube 42 and associated circuits. In tube 42 the audio oscillator section consists of cathode 64, control grid 65 and anode 66. The radio frequency section of the tube consists of cathode 67, grid 68 and anode 69. The two cathodes 64 and 67 are connected together and are connected to ground through the lower half of a variable inductance 70 which is thus common to the cathode circuits of both sections of the tube. A condenser 71 serves as a radio frequency by-pass for the cathodes. The control grid 65 is connected to the cathodes through a resistor 72 and to the inductance 70 through a resistor 73, the switch 40, the switch 25 and certain of the switches 24, depending upon the position of the finger 29. A condenser 74 is shunted across the inductance 70 to complete the audio frequency tuned circuit. The plate 66 is directly connected to the D. C. distributory conductor 52. The grid 68 is coupled to the grid of tube 41 through a condenser 75 and resistor 76. Inductance 77 serves as a radio frequency choke between grid 68 and the cathode circuits. Anode 69 is connected to the D. C. distributory conductor 52 through condenser 78, variable condenser 79 and inductance 80 all connected in parallel and together forming a radio frequency "tank".

In the electrical connections just described, the inductance 70 and condenser 74 form the tuned circuit of the audio frequency section of the tube 42. The grid 65 receives the necessary energy for oscillation from the tuned circuit only when switch 40 is closed and a circuit is complete from said switch through switch 25 and one or more of the push button switches 24 to the inductance 70 and condenser 74. The lower portion of the inductance 70 also forms a part of the cathode circuit of the radio frequency section of the tube 42, so that the potential of the cathode 67 is affected by the oscillating current in the inductance 70. Thus the inductance 70 serves the dual purpose of producing oscillation and controlling the potential of the cathode 67 to modulate the radio frequency energy.

During each cycle of motor operation, the cam 37 and switch 25 are rotated through a complete revolution. The cam 37 is provided with a projecting portion 88 adapted to engage and close the switch 40 for an appreciable period of time at the start of motor operation. Thereafter said switch is engaged by a series of teeth 89 to produce a succession of much briefer momentary actuations of said switch. The operation of switch 40, so long as the circuit is complete through switch 25 and the push button switches 24, thus results in modulation of the radio frequency energy in the form of a single relatively long power impulse followed by a succession of much shorter impulses.

The switch 25 is operated by the motor 34 in timed relation with the operation of the impulse switch 40 and this relation is such that the finger 29 engages the contact segment 27 during the long impulse and the first of the shorter impulses produced by switch 40. The second of the shorter impulses occurs when the finger 29 is in engage-

ment with the first of the contact points 26. Similarly, successive impulses occur while the contact finger is in engagement with successive contact points 26. The contact finger 29 is constantly in engagement with a contact ring 90 connected to the inductance 70 and condenser 74. The contact segment 27 is connected to the switch 40. Thus the modulating circuit is always complete during the long impulse and the first of the shorter impulses. Thereafter the movement of finger 29 introduces the switches 24 successively into the modulating circuit. When a switch 24 which has previously been opened is introduced into the circuit, said circuit is broken and no further power impulses can be produced even though switch 40 continues to operate. For example, if the first of the switches 24 has been selected, the circuit is broken when the finger 29 moves to the first of the contact points 26. The generated signal then consists only of the long impulse and a single shorter one. If the first of the switches 24 is in normal position and the second of said switches has been opened, a second short impulse is added to the signal. Thus the number of short impulses is determined by the selection of the proper switch 24. In the specific construction just described, the switch 25 and selector switches 24 operate upon the modulation circuit. While this is a preferred arrangement, it is obvious that this form of control may be applied to other circuits which control the transmission of the signals.

Radio frequency energy from tube 41 is fed to the grid 68 through the condenser 75 and resistor 76 and is amplified, modulated and impressed upon the tank circuit 78—79—80 by the radio section of the tube 42. The inductance 80 is coupled with an inductance 81, connected in series with an inductance 82 and a condenser 83. The inductances 81 and 82, and the condenser 83 form a link circuit in which currents induced by the coupling with inductance 81 may be tuned by the condenser 83 to eliminate harmonics. The inductance 82 is closely coupled with an inductance 84 and loosely coupled with an inductance 85, and said coupling induces corresponding high frequency energy therein. One terminal of each of the inductances 84 and 85 is connected to the line conductor 44, and the opposite terminals of said inductances may be selectively connected to the line conductor 45 by a switch 86 connected to the last mentioned line conductor through a condenser 87.

By means of the connections just described, the amplified and modulated radio frequency output of tube 42 is impressed upon the line conductors 44 and 45 by either one of the inductances 84 and 85, the particular one of said inductances to be used being chosen by manual operation of the switch 86, and the choice depending upon the impedance of the external circuit between the remote station and the local station and consequent strength of signal required.

From the foregoing description it will be apparent that the transmitter generates and impresses upon the power lines a signal consisting of a high frequency carrier modulated by a single relatively long power impulse followed by a rapid succession of shorter impulses and that the number of shorter impulses in the series is determined by the particular push button switch 24 which has been selected.

Receiver

Power for operating the receiver 17 and the controlled machine 20 is supplied from the plug-

19 to a pair of power lines 100 and 101. A transformer 102 has its primary winding connected to the power lines 100 and 101 and has the terminals of its secondary winding connected to the anodes of a rectifier tube 103. The cathode of said tube is connected to a D. C. distributory conductor 105 and the midpoint of the secondary winding of the transformer is connected to a conductor 107. The conductors 105 and 107 are connected by an external load circuit consisting of resistors 104, 106 and 108 normally connected in series between said conductors. The rectifier tube 103 thus serves as a full wave rectifier to maintain a suitable D. C. potential difference between conductors 105 and 107. One terminal of the resistance 108 is grounded as shown in Fig. 3 and the resistances mentioned are so chosen that conductor 107 carries a negative potential of approximately 95 volts and the conductor 105 carries a suitable positive potential for the plate circuits of the several tubes used in the receiver.

The electrical apparatus of the receiver also includes a radio frequency transformer 103, a pentode tube 110 used for radio frequency amplification, a radio frequency transformer 111, a tube 112 having a diode rectifier section and a triode amplifier section used for audio frequency amplification, a similar tube 113 and a pentode tube 113A. Other electrical elements shown in Fig. 3 will be described in connection with the circuits in which they are included.

The primary winding of the transformer 109 is connected to the line conductors 100 and 101 through condensers 114 and 115 adapted to transmit radio frequency energy but to block the usual 60 cycle commercial current. Thus the modulated radio frequency signals generated in the transmitting apparatus are conducted from the transmitter 10 through the line conductors 12 and line conductors 100 and 101 to the transformer 109 and said signals induce corresponding currents in the secondary winding of said transformer. A tuning condenser 116 is connected in parallel with the secondary windings of the transformer 109 to complete a resonant circuit which may be tuned to the radio frequency of the incoming signals. The resulting signal is impressed on the control grid 117 of tube 110. The cathode 118 of tube 110 is connected to ground through a conventional biasing resistor 119 and condenser 120 and the anode 121 of said tube is connected to the positive D. C. distributory conductor 105 through a tuned circuit consisting of the primary winding of transformer 111 and a tuning condenser 122. The connections just described constitute a conventional stage of radio frequency amplification by means of which the incoming signals are amplified and impressed upon the primary winding of transformer 111.

The secondary winding of transformer 111 is provided with a tuning condenser 123 in parallel therewith to complete a tuned secondary circuit, one terminal of which is connected to the anode 124 of the rectifier section of tube 112. The opposite terminal of said tuned circuit is connected to the cathode 125 of said tube through resistors 126, 127 and 128. The D. C. voltage produced in the circuit just described by operation of the rectifier section of tube 112 appears across the resistors 126, 127 and 128 and is applied to the control grid circuit of tube 110 through a conductor 129 and a filter network consisting of a resistor 130 and condensers 131 and 132 to provide automatic volume control.

The control grid 133 of the amplifier section of tube 112 is connected through a coupling condenser 134 to a point in the rectifier circuit just described where suitable variations in voltage are obtained for the operation of said amplifier section. Said grid is connected to ground through a conventional grid coupling resistor 134A. The cathode 135 is connected to cathode 125 and is biased to ground in a conventional manner. The anode 136 is connected to the D. C. distributory conductor 105 through a resistance 137. The connections just described complete a conventional stage of audio frequency amplification as a result of which a pulsating current of audio frequency corresponding to the transmitted impulses is generated in the circuit of anode 136.

The anode 136 is coupled through a series tuned circuit consisting of a condenser 138 and inductances 139 to a rectifier circuit including the rectifier cathode 140, a variable inductance 141, parallel connected condenser 142, a resistance 143 and the anode 144. The condenser 142 and inductance 141 form a parallel tuned circuit which together with the series tuned circuit 138—139 passes the audio frequency signals of the desired frequency and rejects all others. As a result a rectified current flows in said rectifier circuit during signal impulses and the direction of said current is such that the upper terminal of resistor 143 is at a lower potential than the lower terminal thereof when current is flowing. Between impulses and when the apparatus is standing idle, no rectified current flows and both terminals of resistor 143 are at the same potential—i. e. the potential of the negative D. C. distributory conductor 107 to which the lower terminal is connected.

The cathode 145 of the triode section of tube 113 is connected to the lower terminal of resistance 143 and the control grid 146 is connected to the upper terminal. The anode 147 is connected to ground through a resistance 148. Since the resistances 108, 106 and 104 in the external load circuit of the rectifier 103 are proportioned to maintain the potential of conductor 107 approximately 95 volts below ground potential, the connection of anode 147 to ground gives said anode a potential sufficiently above that of cathode 145 for operation of the triode section of the tube.

In the operation of the second section of tube 113, the cathode 145 and control grid 146 are at the same potential as long as no signal impulses are received. The anode circuit therefore draws a steady direct current from the rectifier 103. When a signal impulse is received the resulting current through resistor 143 depresses the potential of grid 145 to a point where cutoff occurs and the anode current is thereby interrupted for the duration of the signal impulse. The output of tube 113 therefore consists of a steady direct current interrupted during each signal impulse.

In the tube 113A, the cathode 149 is biased to ground through resistance 150, the control grid 151 is directly connected to the anode 147 and so carries substantially ground potential during signal impulses and considerably less than ground potential in the idle state of the apparatus when current flows in the circuit of anode 147 and there is a corresponding voltage drop in resistor 148. The low grid voltage in the idle state biases the tube to cutoff, while the increase during signal impulses is sufficient to permit a strong plate current to flow between the anode 152 and the cathode 149. The output of tube

110A is therefore the reverse of that of tube 113 and consists of a series of current impulses corresponding to the signal impulses received. The anode of tube 113A is connected through the winding of an electromagnet coil 153 to the positive D. C. distributory conductor 105 and said magnet coil may therefore be energized by the flow of current in the anode circuit in response to the signal impulses.

In order to prevent actuation of the magnet 153 by transient impulses of brief duration, there is provided time delay means which initially limits the response of the magnet to impulses of at least a predetermined duration less than the duration of the long impulse with which each signal series is begun but greater than the duration of the shorter subsequent impulses and greater than the duration of spurious impulses apt to be received on the power lines from external sources. When the relay 158 has once been actuated in response to the longer impulse, the time delay device is automatically rendered inactive and remains inactive until a predetermined time after the cessation of a series of impulses. Thus the relay 158 may respond to the briefer signal impulses when they follow normally a longer impulse. The time saving resulting from the use of relatively brief signal impulses is thereby realized without danger that the apparatus may be improperly operated by brief impulses from an external source.

In the preferred form of the apparatus shown in the drawings, the time delay device mentioned in the foregoing paragraph consists of a condenser 154 connected at one side to the anode 147 and control grid 151 and at the other side connected to ground through a normally closed switch 155. A second condenser 156 of much smaller capacity is permanently connected to ground in parallel with condenser 154 and switch 155. The changes in potential of the anode 147 and control grid 151 must be accompanied by corresponding changes in the charges carried by the condensers 154 and 156. The time required to charge both of said condensers when a signal impulse is received is sufficiently great to prevent the grid 151 from reaching an operative potential unless the impulse persists for a predetermined period of time. The capacities of the condensers are so chosen that this predetermined period is less than the duration of the long impulse which begins each signal series but is considerably greater than the duration of the shorter impulses. As long as the condenser 154 remains connected, the magnet 153 cannot respond to the shorter signal impulses but may respond to the longer initial impulse. When the switch 155 has been opened, as hereinafter described, the condenser 154 is disconnected from the circuit and the condenser 156 alone controls the timing of response. The capacity of condenser 156 is sufficiently low to permit accurate response to the shorter signal impulses.

The magnet 153 operates a double throw switch 157 by means of which the resistance 106 is disconnected from the external load circuit of the rectifier 103 and the winding of a relay 158 is substituted therefor in said circuit. The relay 158 operates the switch 155 to disconnect the condenser 154 and render the apparatus responsive to the shorter signal impulses. The relay 158 is of the slow drop type in which the drop-out time is less than the normal interval between signal impulses. The switch 155 thus remains open throughout a series of signal im-

pulses and is closed only after the lapse of a predetermined time after the last of such a series. Said predetermined time is determined by the drop-out time of the relay 158.

The substitution of the relay coil 158 for the resistance 106 in the load circuit of the rectifier 103 insures that the resistance characteristics and potential characteristics remain substantially the same. This is made possible by the fact that the resistance of the windings of relay 158 is made substantially the same as that of the resistance 106. Furthermore, condensers 159 and 160 of relatively large capacity connected across said load circuit resist sudden changes in potential characteristics. When switch 155 is operated by relay 158, a front contact of said switch connects a resistance 161 in parallel with the resistance 108. The resistance 161 provides an additional current path to carry the increased current in the lower portion of the load circuit caused by operation of the magnet 153 and thus insures that said operation does not materially disturb the voltage characteristics of said load circuit. The relay 158 also operates a double throw switch 162 which disconnects the resistance 104 from the rectifier load circuit and connects the winding of a slow drop magnet 163 in its place. The purpose of the operation of said magnet will be described hereinafter.

Briefly recapitulating the operation of the apparatus just described, the magnet 153 responds first to the long initial signal impulse and in so doing actuates magnet 158. Magnet 158 operates switch 155 to disconnect condenser 154 and render the magnet 153 responsive to the shorter impulses. Magnet 158 also actuates magnet 163 through switch 162. During a series of impulses the magnet 153 is repeatedly actuated and magnets 158 and 163 remain continuously in actuated position. At the end of a series of impulses, magnet 158 drops out and at a predetermined time thereafter, depending upon its drop-out time, magnet 163 returns to its normal position.

Referring now to Figs. 4, 5 and 6, there is shown therein mechanical apparatus controlled by the magnets 153 and 163. Said apparatus includes a stationary frame 164 in which there is mounted a rotatable shaft 165. Said shaft has secured thereto a ratchet wheel 166 and a pair of contact fingers 167 and 168. The contact finger 167 is adapted to engage contact points 169 mounted on an insulation plate 170 and the finger 168 is adapted to engage a contact segment 171 mounted on said plate. The fingers 167 and 168 are electrically connected to each other but suitably insulated from the shaft 165 and other parts of the apparatus. The magnet 153 is mounted on a core 172 suitably supported on the frame 164 and is provided with an armature 173 mounted on a rocking collar 174 which is freely carried on the shaft 165. The rocking collar 174 is provided with an arm 175 carrying a pawl 176 adapted to engage the teeth of the ratchet wheel 166. The rocking collar 174 is normally held in the position shown in the drawings by a tension spring 177 and the pawl 176 is urged toward engagement with the ratchet 166 by a tension spring 178. In the idle position however, the spring 177 holds the pawl 176 against a stop pin 179 and retains said pawl out of engagement with the ratchet. The rocking collar 174 is provided with an insulated pin 180 adapted to engage and actuate the switch 157.

In the operation of this portion of the apparatus each actuation of the magnet 153 draws

the armature 173 toward said magnet and rocks the collar 174 on the shaft 165. At each such operation the pawl 176 engages the ratchet 166 and advances the same a distance corresponding to one tooth of the ratchet. Each such advance also corresponds to the spacing of the contact points 169 so that the finger 167 is brought successively into engagement with said contact points.

The magnet 163 is provided with a core 181 mounted on the frame 164 and provided with a number of copper slugs 182 to provide the necessary slow drop action. Said magnet has an armature 183 normally held against a stop 184 by a tension spring 185. Said armature carries a resilient finger 186 engaging a pin 187 carried by a pawl 188 which is pivotally mounted on the frame 164 by means of a pivot screw 189. The armature 183 also carries a rigid finger 190 adapted to engage the undersurface of the pin 187.

In the operation of the magnet 163 the finger 186 resiliently presses the pawl 188 against the ratchet 166 and prevents counterclockwise movement of said ratchet, referring to Fig. 5, while permitting clockwise movement of said ratchet by operation of the magnet 153. When the magnet 163 is deenergized at the end of a series of signal impulses, the finger 190 positively lifts the pawl 188 clear of the ratchet wheel 166 and permits said ratchet wheel to be returned to normal position by a tension spring 191 anchored at one end of the frame 164 and at the other end anchored to the shaft 165.

Referring again to Fig. 3, there is shown therein the controlled machine 20 in diagrammatic form. Said machine may be an automatic phonograph of the type disclosed in Wilcox Patent No. 2,002,236 in which there is provided electromagnetic control of the selection of phonograph records. Said machine has a series of electromagnets 192 which may correspond to the magnets 175 of the Wilcox patent, each of which controls the selection of a certain phonograph record. There is also provided a magnet 193 which may be considered as corresponding to the magnet 158 of the Wilcox patent and which initiates an operation of the machine. Speaking more generally, the magnets 192 and 193 may be considered as representing any suitable electrical elements for the control of mechanical or electrical apparatus. Each of the magnets 192 is connected to one of the contact points 169 and each has its opposite terminal connected to the power line 100. The contact segment 171 and the magnet 193 are connected to one terminal of a normally open switch 194 operated by the magnet 163. The opposite terminal of said switch is connected through a normally closed switch 195 to the power line 101. The switch 195 is operated by the relay 158.

In the operation of the parts just described, the magnet 153 is actuated in response to the initial long signal impulse and the magnets 158 and 163 are then actuated in sequence. Switch 195 is opened before switch 194 is closed so no electrical connection is made through said switches. The actuation of magnet 163 presses the pawl 188 into engagement with the ratchet wheel 166 and prevents reverse movement of the selector finger 167 during the intermittent operation of magnet 153. Successive actuations of magnet 153 in response to a given number of the shorter signal impulses advances the selector finger 167 to one of the contact fingers 169 depending upon the number of shorter impulses in

the series. Said selector thus conditions the circuit of the corresponding magnet 192 for subsequent operation. At the end of a series of signal impulses, magnet 158 drops out and closes switch 195. Due to the delayed action of magnet 163, switch 194 remains closed for an appreciable time thereafter. During this period circuits are completed for the selected magnet 192 and for the magnet 193. The corresponding phonograph record is thereby selected and the phonograph is set into operation. When the magnet 163 finally drops out, the circuits just mentioned are broken and the pawl 188 is released to permit the spring 191 to return the selector 167 to initial position. Said initial position is determined by a rigid finger 196 secured to the shaft 165 and engaging a stationary stop pin 197.

By means of the apparatus just described the time of transmission of a series of signal impulses has been greatly reduced. The shorter signal impulses may be transmitted at the rate of 20 per second and the longer initial impulse may be as short as a sixth of a second. When a selection of 24 operations is provided, the entire cycle of transmission may be run through in less than two seconds. This speed of operation is of particular importance where a number of remote stations are used to control a single machine since it reduces to a negligible factor the chance of simultaneous operation of two transmitters.

The invention has been described in one of its preferred forms, the details of which may be varied by those skilled in the art without departing from the scope of the invention as defined in the appended claims.

For example, different forms of time delay devices may be used to prevent operation of relay 153 in response to short impulses not preceded by the initial long impulse, and one such alternative arrangement is shown in Fig. 7. In that figure there is shown a portion of the apparatus of Fig. 3 and parts common to both arrangements are indicated by similar reference numbers. The time delay device consists of an inductance 254 connected between the anode 147 of tube 113 and the resistor 143. Electrical energy is stored in said inductance at each signal impulse and the connection is such that operating potential is not built up on grid 151 until a predetermined quantity of such energy has been stored. A switch 255, operated by the relay 158 when relay 153 has once been energized, is connected to short-circuit the inductance 254 and thus remove said inductance from effective connection to the circuit. Thereafter the relay 153 may respond to the shorter impulses.

The invention claimed is:

1. In an impulse receiver for a remote control system, the sub-combination of an electrical unit responsive to signal impulses received by said receiver, a time delay device associated therewith and normally limiting response of said electrical unit to impulses of greater than a predetermined duration, switching means controlled by actuation of said electrical unit and adapted to render said time delay device inactive, whereby said electrical unit becomes responsive to impulses of shorter duration, and other time delay apparatus actuated by response of said electrical unit to the shorter impulses and associated with said switching means to delay return thereof to initial position for a predetermined period after each such actuation, whereby said first mentioned time delay device remains inactive through a

series of the shorter impulses following the initial long impulse by an interval less than said predetermined period and occurring at intervals less than said predetermined period.

2. In an impulse receiver for a remote control system, the sub-combination of a relay, electrical circuits adapted to operate said relay in response to signal impulses received by said receiver, a time delay device associated with said circuits and normally limiting response of said relay to impulses of greater than a predetermined duration, and a slow drop relay actuated by operation of said first relay and controlling the operation of said time delay device to render the same inactive, whereby said first named relay may respond to an initial impulse of greater than said predetermined duration and may then respond to a series of shorter impulses occurring at intervals not greater than the drop-out time of said slow drop relay and following the initial impulse, at an interval not greater than said drop out time.

3. In an impulse receiver for a remote control system, the sub-combination of a relay, electrical circuits adapted to operate said relay in response to signal impulses received by said receiver, a condenser associated with said circuits and normally arranged to be charged at each signal impulse and to delay operation of said relay while being charged, whereby said relay is normally unresponsive to an impulse of less than a predetermined duration, a slow drop relay actuated by operation of said first named relay, and switching means connected to said condenser and controlled by operation of said slow drop relay to disconnect said condenser from said circuits when said slow drop relay is energized, whereby said first named relay then becomes responsive to a series of shorter impulses occurring at intervals less than the drop-out time of said slow drop relay.

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